Hydrogen does not decompose the dry salt, even with the aid of sunlight, nor does a stream of that gas decompose an aqueous solution of the salt, but the dry salt is rapidly and perfectly decomposed by that gas at an incipient red heat, its metal being liberated.

Nitrogen has no chemical effect upon the salt, even at a red heat, nor upon its aqueous solution. Dry ammonia gas is copiously absorbed by the dry salt. In one experiment the salt absorbed about 844 times its volume of the gas. The salt in a fused state is rapidly and perfectly decomposed by dry ammonia gas, and its silver set free. A saturated solution of the salt is also instantly and violently decomposed by strong aqueous ammonia.

Oxygen has no effect either upon the dry salt at 15° C., or at a red heat, nor upon its aqueous solution. Steam perfectly and rapidly decomposes the salt at an incipient red heat, setting free all its silver. No chemical change took place on passing either of the oxides of nitrogen over the salt in a state of fusion.

By passing anhydrous hydrofluoric acid vapour over perfectly anhydrous and previously fused fluoride of silver, at about 60° Fahr., distinct evidence of the existence of an acid salt was obtained. This acid salt is decomposed by a slight elevation of temperature.

Numerous experiments were made to ascertain the behaviour of argentic fluoride in a state of fusion with chlorine, and great difficulties were encountered in consequence of the extremely corrosive action of the substances when brought together in a heated state. Vessels of glass, platinum, gold, charcoal, gas carbon, and purified graphite were employed*. By heating the salt in chlorine, contained in closed vessels, formed partly of glass and partly of platinum, more or less corrosion of the glass took place, the chlorine united with the platinum and fluoride of silver to form a double salt, and a vacuum was produced. By similarly heating it in vessels composed wholly of platinum, the same disappearance of chlorine, the same double salt, and a similar vacuum resulted. Also, by heating it in vessels composed partly of gold, an analogous double salt, the same absorption of chlorine and production of rarefaction were produced. And by employing vessels partly composed of purified graphite, a new compound of fluorine and carbon was obtained.

III. "Approximate determinations of the Heating-Powers of Arcturus and *a* Lyræ. By E. J. Stone, F.R.S., First Assistant at the Royal Observatory, Greenwich. Received October 13, 1869.

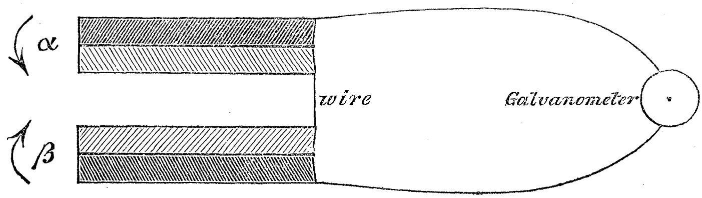
About twelve months ago I began to make observations upon the heating-power of the stars. My first arrangements were simply these: I made

* In the next communication will be described the results obtained with vessels formed of other materials.

use of a delicate reflecting astatic galvanometer, and a thermo-electric pile of nine elements. The pile was screwed into the tube of a negative eye-piece of the Greenwich Great Equatoreal, from which the eye-lenses had been removed.

I soon convinced myself that the heat, condensed by the object-glass of twelve and three-quarters inches upon my pile, was appreciable in the case of several of the brighter stars; but the endless changes in the zero-point of the galvanometer-needle, and the magnitude of these changes, compared with those arising from the heating-power of the stars, prevented me from making any attempts to estimate the absolute magnitude of the effects produced. Every change in the state of the sky, every formation or dissipation of cloud, completely drove the needle to the stops.

At the February Meeting of the Royal Astronomical Society I first became aware of what Mr. Huggins had done upon this question. His arrangements, however, did not appear to me to meet the difficulties which I had encountered. After some trials, I arranged my apparatus as follows, and with its present form I am satisfied.



α and β are two pairs of plates of antimony and bismuth. The areas are about $(0{\cdot}075)^2$ inches, and their distance is about 0·25 inch.

The poles are joined over in opposite directions to the terminals of the pile and galvanometer. The whole pile is screwed into a tube of one of the negative eyepieces of the great equatoreal. This completely shuts the pile up in the telescope-tube. A thick flannel bag is then wrapped over the eyepiece and terminals. The bag is prevented from actually touching the case of the pile, and is useful in preventing the irregular action of draughts upon the case of the pile and terminals. The wires are led from the terminals of the pile to the observatory library, where I have placed the reflecting galvanometer. This separation of the galvanometer from the telescope is most inconvenient, but it was absolutely necessary on account of the large moving masses of iron in the observing-room.

The two faces α and β of the pile are so nearly alike, that the resultant current generated by any equal heating of them is exceedingly feeble.

The telescope is first directed so that the star falls between the faces α and β, and allowed to remain thus until the needle is nearly steady at the zero.

The star is then placed alternately upon the faces α and β, and the corresponding readings of the galvanometer taken as soon as the needle appears to have taken up its position, which usually takes place in about

ten minutes. In order to avoid changes of zero, I have always reduced those readings by comparing a reading with star on face α with the mean of two readings with star on β, taken before and after the reading with star on α, or *vice versâ*.

With this precaution I have never met with any anomalous results, although in making the observations I have usually joined over the terminals, without knowing the direction for heat, and have left this undetermined until the completion of the observations. I mention this because the differences in the readings for star on α and star on β in the state in which I use my galvanometer are small.

On many nights, when very slight appearances of cloud prevailed, I have not been able to make any satisfactory observations at all.

The number of divisions over which the spot of light travels on the galvanometer-scale for a given difference of temperature of the faces α and β is of course dependent upon many circumstances, and especially upon the position of the sensitiveness-regulation magnet of the galvanometer.

I have thought it useless, therefore, to publish any results unless obtained upon nights when the state of the galvanometer was eliminated by referring to an independent source of heat. The way in which this has been attempted is as follows:—

After obtaining the differences in the position of the spot of light on galvanometer-scale for star on α and star on β, I remove the pile from the telescope, leaving all its galvanic connexions untouched, and mount the pile so that of the two halves of the face of a Leslie's cube, containing boiling water, each radiates heat upon one face, α or β of the pile, placed at a known distance of about twenty inches from the cube. After some time the deflection of the needle will fall nearly to zero, and become steady enough for observation. A piece of glass, G, is then placed to intercept from β a portion of the heat radiating from one half of the face of the cube, and when the needle has taken up its position, the reading is taken. Next the glass G is placed to intercept a portion of the heat from the face α, and the galvanometer-reading taken, as before, as soon as the needle has assumed its position of rest.

If, then, θ is the mean difference of readings for star on face α and face β, ϕ the mean difference for glass before β and α, C the heating-power of each half of the cube at its distance from the faces of the pile, and p the measure of the absorption of the piece of glass G, then the heating-power of star

$$=\frac{\theta}{\phi}\times C \times p.$$

The quantity p has been determined by merely comparing the readings of the galvanometer, obtained by cutting off the whole heat from one-half of the cube, with that obtained by intercepting a portion of this heat by the glass G. A considerable number of accordant results gave $p=0 \cdot 725$.

To determine the quantity C, I have proceeded as follows:—

1st. I have placed two very delicate thermometers, one in contact with each face α and β of the pile, along the lines of junction of the plates. The thermometers were separated from each other, and the direct radiation of one on the other prevented by the interposition of a piece of blackened card. The two thermometers, with faces of pile in contact, were then exposed to the radiation of the halves of the face of the cube containing the boiling water. A third delicate thermometer was read for registration of any change in the temperature of the surrounding air. This thermometer was protected from the direct radiation from the cube. The pile, with thermometers in contact, was then placed at different distances from the cube and the thermometer-readings taken. I have usually taken readings at three distances, one at about 23·5 inches, another at 11·9 inches, another at 2·5 inches. From a comparison of these readings with those taken before the heat from the cube fell upon the thermometers, I infer the heating-power of each half of the cube upon the thermometers, with faces of pile in contact. Calling this quantity for one inch of distance H', I find for my cube in its present state, with slightly laquered face, $H'=130°$ F.

2nd. If H denote the corresponding heating-power of each half of the cube upon the faces of the pile α and β, I have found the ratio $H : H'$ as follows :—

The thermometers being placed in contact with the faces of the pile, and the galvanic connexions made, we may be certain that the temperature of the thermometers has been imparted to the faces of the pile when the needle is steady, provided that the current be carried from the thermometers without loss in the nature of increased resistance. I have therefore compared the deviations produced by glass G before the faces β and α with the thermometers in contact and without thermometers in contact with two different amounts of resistance in circuit. Such observations have been considered satisfactory only when the two resistances for thermometers in contact and without thermometers are sensibly equal. This condition can be obtained by making the thermometers touch along the lines of junction of the antimony and bismuth ; but the connexion being one of mere contact, there is always danger of failure.

The following observations were made on 1869, Aug. 19 :—

1. Without thermometers :
   Resistance $=R+0·003$ B.A. units.
   Mean difference, G before $\beta-$G before $\alpha=735$ div.
2. With thermometers in contact :
   Resistance $=R_1+0·003$ B.A. units.
   Mean difference $=698$ div.
3. With thermometers in contact :
   Resistance $=R_1+1·437$ B.A. units.
   Mean differences$=324$ div.

4. Without thermometers:

Resistance R+1·437 B.A. unit.

From (1) and (4) R=1·251 B.A. unit.

From (2) and (3) R_1=1·239 B.A. unit.

The resistances are therefore each sensibly equal to 1·245 B.A. unit.

From (1) (2) and (3) (4) we find $\frac{H}{H_1}=1{\cdot}056$.

From the mean of such determinations I find

$$\frac{H}{H_1}=1{\cdot}087.$$

If, therefore, c is the distance of the pile from the cube in inches, we have

$$C=\frac{130^\circ}{c^2}\times 1{\cdot}087.$$

And the heating-power of the star

$$=\frac{130^\circ}{c^2}\times 1{\cdot}087\times 0{\cdot}725\times\frac{\theta}{\phi}.$$

I may mention that the whole area of a face of the small pile may be considered as effective in the focus of the equatoreal.

The following observations have been made and reduced as above:—

1869. Aug. 2.

Observations of Arcturus, altitude about 25°.

$$\theta=23 \text{ div.}$$
$$\phi=160 \text{ div.}$$
$$c=17{\cdot}6 \text{ inches.}$$

Heating-power of star

$$=\frac{130}{(17{\cdot}6)^2}\times 1{\cdot}087\times 0{\cdot}725\,\frac{23}{160}\left(\frac{17}{37{\cdot}5}\right)$$
$$=0^\circ{\cdot}0216 \text{ F.}$$

For the observations ϕ the scale was removed nearer the galvanometer so that the effective radius for these readings was 2×17 inches against 2×37·5 inches for the observations of the star.

1869. August 11.

Observations of Arcturus.

$$\theta=27 \text{ div.}$$
$$\phi=114 \text{ div.}$$
$$c=24 \text{ inches.}$$

Effective radius for observations, 32 inches.

Heating-power of Arcturus

$$=\frac{130}{(24)^2}\times 1{\cdot}087\times 0{\cdot}725\times\frac{27}{114}\times\frac{32}{75}$$
$$=0^\circ{\cdot}0180 \text{ F.}$$

The mean result of the observations on these two nights is

$$0^\circ{\cdot}0198 \text{ F.}$$

as a measure of the heating-effect of Arcturus in raising the temperature of the plate of antimony and bismuth when the heat is condensed by the object-glass of 12·75 inches.

If the absorption by the object-glass be considered insensible, the direct effect upon the pile would be

$$0^\circ{\cdot}000000685 \text{ F.}$$

I have not yet determined the coefficient of absorption for the object-glass, but if it be provisionally taken at $\frac{1}{2}$, the direct heating-effect of Arcturus

$$=0^\circ{\cdot}00000137 \text{ F.}$$

The result may be otherwise stated as follows:—That the heat received from Arcturus is sensibly the same as that from the whole face of the cube containing boiling water at 400 yards.

1869. August 14.

Observations of β Lyræ at 8^{h} 38^{m} G.M.T.

$$\theta=15 \text{ div.}$$
$$\phi=686 \text{ div.}$$

Heating-power for β Lyræ

$$=\frac{130}{(24)^2}1{\cdot}087\times 0{\cdot}725\ \frac{15}{686}=0{\cdot}0039 \text{ F.}$$

Observations were subsequently made of α Lyræ, but the zero was unsteady; and as the night advanced clouds appeared, and ultimately interrupted the observations.

1869. August 14.

α Lyræ. Star on a— star on $\beta=11$ div.

1869. August 15.

The night was very clear, and the air steady, but completely saturated with moisture, at a temperature of about 52°. The mean of fourteen observations of the difference of reading for a Lyræ on a and β gave only 11 divs. I have no doubt but that the small effect here obtained was due principally to the amount of moisture in the air.

1869. August 25.

Observations of α Lyræ. Night fine.

Mean value of the difference from nine observations was

$$\theta=33 \text{ div.}$$
$$\phi=669 \text{ div.}$$
$$c=24 \text{ inches.}$$

$\therefore$ heating-power of α Lyræ $=0^\circ{\cdot}0088$ F.

This result is again so much smaller than those obtained from Arcturus, although the observations of Arcturus were made under more unfavourable circumstances with respect to altitude, that I cannot but regard it as a fact

that the star Arcturus does give us more heat than α Lyræ,—a result probably due to the same cause which gives rise to the difference in colour between these stars, viz. the greater absorption of the red end of the spectrum in the case of α Lyræ than in the case of Arcturus.

I may here mention that on June 25, 1869, I made a direct comparison between Arcturus and α Lyræ. The result gave for the heat received from Arcturus : that from α Lyræ : : 3 : 2 ; but on account of the observations of α Lyræ having been interrupted by cloud, they were not sufficiently numerous to eliminate mere errors of reading.

From the whole of these observations I think we may conclude that Arcturus gives to us considerably more heat than α Lyræ ; that the amount of heat received is diminished very rapidly as the amount of moisture in the air increases; that nearly the whole heat is intercepted by the slightest cloud; that as first approximations, the heat from Arcturus, at an altitude of 25°, at Greenwich is about equal to that from a three-inch cube containing boiling water at a distance of 400 yards.

The heat from α Lyræ at an altitude of 60° is about equal to that from the same cube at a distance of about 600 yards. The form given to the pile appears likely to be useful in many inquiries respecting differences of heating-power.

January 20, 1870.

Dr. WILLIAM ALLEN MILLER, Treasurer and Vice-President, in the Chair.

The Presents received were laid on the Table, and thanks ordered for them, as follows :—

Transactions.

Christiania :—Kongelige Norske Frederiks Universitet. Aarsberetning for Aaret 1868. 8vo. *Christiania* 1869. Index Scholarum, 1869. 4to. *Christiania* 1869. Forhandlinger i Videnskabs-Selskabet i Christiania, Aar 1868. 8vo. *Christiania* 1869. Forhandlinger ved de Skandinaviske Naturforskeres, tiende Möde i Christiania fra den 4de til den 10de Juli 1868. 8vo. *Christiania* 1869. Nyt Magazin for Naturvidenskaberne. Bind I. Heft 1, 1835 (1869); Bind XVI. 8vo. *Christiania* 1869. Anton Rosing, Biographie, par P. Chr. Asbjörnsen. 8vo. *Christiania* 1869. La Norvège Littéraire, par P. Botten-Hansen. 8vo. *Christiania* 1868. Traité Elémentaire des Fonctions Elliptiques, par O. J. Broch. 8vo. *Christiania* 1867. Quellen zur Geschichte der Taufsymbols und der Glaubensregel von C. P. Caspari. II. 8vo. *Christiania* 1869. Micrometric Examination of Stellar Cluster in Perseus, by O. A. L. Phil. 4to. *Christiania* 1869. Skolevœsenets Ordning i Massachusetts, af H. Rissen. 8vo. *Christiania* 1868. Le Glacier de Boium en Juillet